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THE NERVE ELEMENTS IN HEALTH AND DISEASE.

Being the Prize Series of Photo-micrographs of the American Microscopical Society, 1894.

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The elementary constituents of the nervous system comprise, nerve cells, nerve fibers, and nerve supporting or neuroglia tissue. The function of the cell is the generation of an impulse, of the fiber its transmission, while the function of the neuroglia is to unite and support the nerve elements so as to insure successful termination.

Figure 1.—The nerve cell or ganglion cell, the active constituent of the nervous system, is composed of a mass either pyramidal, spherical, pyriform, or ellipsoidal, of protoplasm, from which prolongations or processes one or many project in various directions. This mass of protoplasm is either of a granular or striated structure, contains a clear rounded or oval nucleus surrounding a nucleolus, and small particles of yellowish pigment granules. Every fully developed nerve cell gives off one or more processes or poles, which either, after a brief course becomes invested with a myelon sheath and proceeds as a nerve fiber, or may continue in the original condition connecting with blood vessels and lymphatics, serving as feeders to the cell body. The former called axis-cylinder, or Deiter's processes, give off many collaterals during their course and end in a brush-like expansion or end brush connecting with other nerve units or neurons. The second or protoplasmic processes do not connect with other nerve processes, but divide, sub-divide and anastomose, forming a network of slender protoplasmic threads, interlacing with the fibrils of other cells but probably not uniting with them.

According to Golgi and others, the multipolar ganglion cells may be divided into two types. In the cells of the first or *motor* type, the axis cylinder processes are directly continuous with the axis cylinders of the nerve fibers. In the second or *sensory* type, the axis cylinder processes divide into a plexus of fibers forming a complex basket-like mass, out of which a single nerve finally emerges.

The size of the ganglion cells vary from 10 μ to 100 μ, the motor cells of the ventral cornua of the myelon and those of the motor zones in the brain being the largest.

Figure 2.—The ganglion cells are situated in the gray cortex of the cerebrum and cerebellum, gray cornua of the myelon and in the spinal and peripheral ganglia. In the myelon they lie within the peri-ganglionic lymph spaces which vary in size according as the cells are in a state of rest or fatigue. When fatigued, the protoplasm of the cells is shrunken and contracted, and the lymph spaces are consequently larger and more conspicuous. As soon as the cells regain their normal rest and vigor they resume their usual size, and the lymph spaces become correspondingly smaller. These peri-cellular spaces are limited by a delicate elastic hyaline membrane, and are lined with nucleated endothelial plates. The gray matter surrounding the ganglion cells is composed of a modified form of neuroglia and connective tissue cells, the *substantia spongiosa* including within its meshes, medullated and non-medullated nerve fibers of varying sizes, blood vessels, lymphatics, and the protoplasmic and axis-cylinder processes of the ganglion cells.

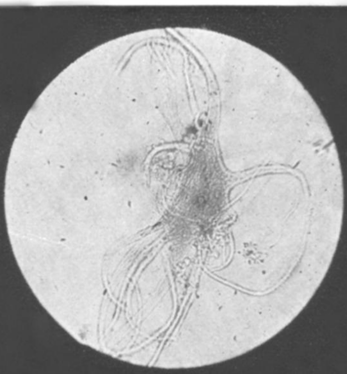
Figure 3.—The pathological changes occurring in the gray matter of the myelon, the result of some acute or sub-acute inflammatory process are in all cases most disastrous to the ganglion cells and their immediate surroundings. There follows such inflammation, hyperplasia of the connective tissue, marked increase of the glia cells infringing upon and destroying in part or in whole the ganglion cells, and the substitution therefor of a dense fibrous or sclerotic tissue. The contraction of this newly formed tissue may even lead to the formation of cavities in the gray matter. Along with the sclerosis there is also present cell proliferation, blood vessel changes and disturbances in the lymphatic circulation. This process is termed a poliomyelitis and is most common in infant life, although adult forms are often met with.

Figure 4.—The neuroglia or supporting tissue of the nervous system is derived from the ectoderm and is composed of glia cells

having a rounded or stellate body from which thread-like processes ramify in all directions, filling up the interstices between the cell bodies, nerve fibres and cell processes. These cells have a nucleus and stain readily with the carmine dyes, but particularly well with the Golgi silver nitrate method. They appear in Golgi preparations as small black spider-like figures with innumerable arms and have received the designation "spider cells." Their function is to unite and hold together the nerve elements, and in the white matter of the myelon they are materially aided by prolongations from the pia dividing and subdividing, forming a veritable skeleton for the support of the nerve fibers, and for protection to the blood vessels and lymphatics entering or departing from the myelon.

Figure 5.—The function of the neuroglia cells is typically manifested in the white matter of the myelon where they serve to unite and support the bundles of nerve fibers. They are not distinguishable, however, except in places where the cell body is perchance transected, and then appear as oval or ellipsoidal masses between innumerable nerve fibers. The cross section of the nerve fibers appears like a mass of cells having a nucleus surrounded by a homogeneous substance and separated from each other by a well defined capsule. These apparent cells are the transected nerve fibers, the supposed nuclei being the axis cylinders and the homogeneous substance surrounding them being the medullary substance or white substance of Schwann. Unlike the peripheral nerve fibers, the medullary sheath is not present in the cerebrospinal nerve fibers the surrounding neuroglia being sufficient for their protection. These fibers are of varying sizes, ranging from 1 μ to 20 μ, the largest belonging to the motor conductors, the smallest to the sensory. The former are found especially in the direct and crossed pyramidal tracts, the latter in the columns of Goll.

Figure 6.—By far the most prevalent lesion of the white matter of the myelon is that of sclerosis, the result of an inflammatory process. As in sclerosis of the gray matter, so here also is found a marked increase in the number of neuroglia cells, with hyperplasia of the pial prolongations. As a result the nerve fibers are encroached upon, and as the process continues they are suffocated, destroyed and finally obliterated by the encroaching newly devel-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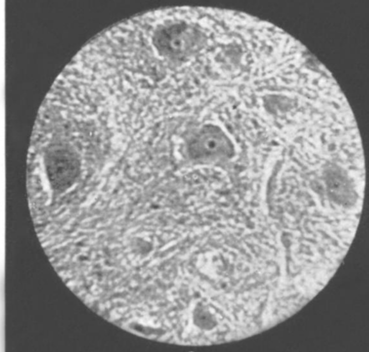
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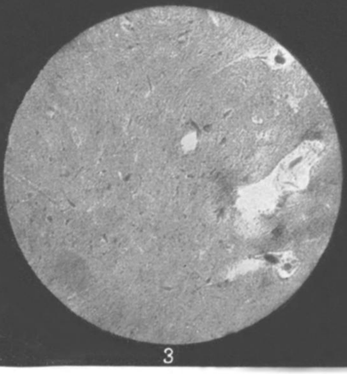
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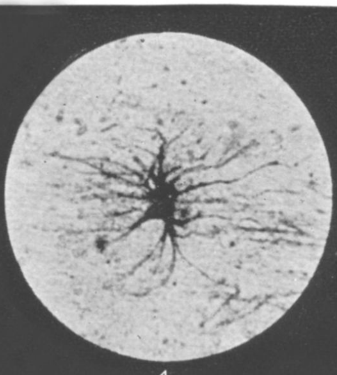
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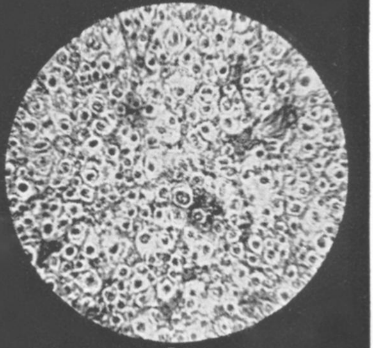
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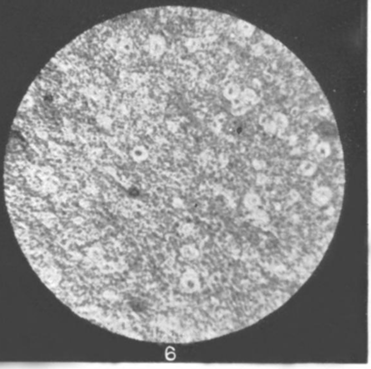
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oping tissue. Entire tracts or systems, or the myelon *in toto* may be converted by disease into a solid or nearly solid mass of sclerotic tissue, perhaps here and there a nerve fiber remaining intact, a vestige of the once normal condition.

EXPLANATION OF PLATE.

Figure 1. Large multipolar ganglion cell from the ventral cornu of the myelon, showing nucleus, nucleolus, protoplasmic and axis cylinder processes. Ammonia carmine stain. Magnified 500 Diameters.

Figure 2. Section of ventral cornu of the myelon in a *normal* condition, showing the multipolar ganglion cells within the periganglionic spaces and surrounded by the substantia spongiosa. Magnified 150 Diameters.

Figure 3. Section of ventral cornu of the myelon in a *pathological* condition. (Poliomyelitis anterior.) The process has destroyed all the ganglion cells and in their stead a dense mass of sclerotic tissue is found. Compare with Figure 2. Magnified 100 Diameters.

Figure 4. A glia or neuroglia cell with its branching processes. Golgi stain. Magnified 500 Diameters.

Figure 5. Section from the white matter of the myelon in a *normal* condition, showing the cross section of the nerve fibres with their axis-cylinders surrounded by the white substance of Schwann. The bodies of several glia cells are shown, but the processes are not distinguishable. Magnified 150 Diameters

Figure 6. Section of the white matter of the myelon in a pathological condition (Sclerosis), showing the almost complete destruction of the nerve fibres and the substitution therefor of a sclerotic fibrous tissue. Several healthy nerve fibers are seen still intact, but the great majority have disappeared. Compare with Figure 5. Magnified 100 Diameters.

Figures 1, 2, and 3 represent therefore the normal and pathological condition of the gray matter of the myelon, while figures 4, 5, and 6 represent the normal and pathological condition of the gray matter.